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ON THE IDENTITY OF *Heteroconger longissimus* GÜNTHER 1870 AND *Heteroconger halis* (BÖHLKE 1957) (PISCES CONGRIDAE)

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With 6 figures and 2 tables

RESUMO. No presente trabalho os autores demonstram que *Heteroconger halis* (Böhlke, 1957) é um sinónimo de *Heteroconger longissimus* Günther, 1870. É feito um historial dos assinalamentos desta espécie até à data e é descrito um método simples e expedito para a sua captura com auxílio de mergulhadores amadores. Para este trabalho foram examinados exemplares da Madeira e do Senegal, considerados como *H. longissimus* e exemplares das Canárias e do Atlântico Ocidental considerados como *H. halis*. Foram feitas contagens de vértebras em exemplares diafanizados, várias medições do corpo e contagem dos poros cefálicos. Cada exemplar, num total de 69, foi descrito por um conjunto de 22 valores, sendo aplicado o método numérico de Análise de Componentes Principais a uma matriz com a dimensão 69 x 22. A semelhança morfológica observada em todos os exemplares examinados de ambos os lados do Atlântico é objectivamente demonstrada pela análise de componentes principais, pelo que se conclui que *H. halis* é sinónimo de *H. longissimus*, tendo este último precedência.

1. INTRODUCTION

The garden eel *Heteroconger longissimus* was described very briefly in 1870 by Günther based on a specimen from Lanzarote in the Canary Islands presented by R.T. Lowe. Subsequently Jordan & Davis (1892), Vinci-

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guerra (1893), Metzelaar (1919) and Fowler (1936) included it in their lists concerning the same geographical area.

Maul (1948) recorded the species from Madeira and Bauchot & Bassot (1958) gave the first account of the colonies existing along the coast of this island. Based on observations made by Dr. Trewavas on the holotype (a very ragged specimen), Böhlke (1957) placed *H. longissimus* in the genus *Taenioconger*, established by Herre in 1923. In the same paper Böhlke described a species (including its osteology) which he called *Nystactes halis*, based on material collected in the Bahamas and Puerto Rico. *Nystactes* being preoccupied [in birds and mammals] was replaced by *Nystactichthys* (Böhlke, 1958).

Kanazawa (1961) redescribed *Taenioconger longissimus* (Günther) from two specimens collected in Senegal. The species was included in the papers by Cadenat (1961) and Blache & Bauchot (1976). These two last authors gave a more detailed description of the specimens previously studied by Kanazawa (1961), and stated that except for the more or less hardened tail tip and the degree of regression of caudal rays nothing clearly distinguishes *H. longissimus* from *N. halis*. Blache (1977) pointed out that *N. halis* was very close to *H. longissimus*.

Böhlke & Chaplin (1968) considered the West Atlantic eel close to and possibly not distinct from an eastern Atlantic species named previously.

Klauswitz (1971) identified specimens from Tenerife in the Canary Islands as *N. halis* and compared his material with specimens from Curaçao and the coast of Colombia (Santa Maria). Brito & Cruz (1981) also identified the material they collected in the same region as *N. halis* and gave data on its habitat and distribution. Saldanha (1982) pointed out the similarities between *T. longissimus* and *N. halis* and gave some data on the distribution of individuals in the colony and on feeding habits.

An approach concerning these similarities was also made when Randall (1967) refrained from recognizing *Nystactichthys* relegating *N. halis* to *Taenioconger* and subsequently Böhlke & Randall (1981) considered *Taenioconger* included in *Heteroconger* comprising "all species having the free upper labial flange continuous across the anterior midline and with the anteriormost lateral-line pore and nostril opening on its anterior face". These authors only recognize two genera for the Heterocongrinae: *Heteroconger* and *Gorgasia* (Böhlke & Randall, 1981). Dooley *et al.* (1985) included *Heteroconger longissimus* and *Heteroconger halis* (still under the generic name of *Nystactichthys*) in their checklist of the shorefishes of the Canary Islands.

Pursuing a program on the biology and habits of *H. longissimus* along the coast of Madeira we were again struck by the close similarities between the two species. Pursuing this subject further we would mention that since the discussion of the problem with Böhlke (by G.E. Maul) of long ago one of us (L.S.) had an additional opportunity of discussing the matter with Böhlke who, however, continued to be more inclined to consider the two

taxa separate species. For D. Smith (pers. com.) the distinction between the two species is slight and somewhat uncertain.

The aim of this paper is to compare specimens from both sides of the Atlantic and see if *H. longissimus* and *H. halis* are conspecific. For this we used classical taxonomy and principal component analysis.

2. MATERIAL AND METHODS

Collecting at sea:

Collecting garden-eels by scuba diving in Madeiran waters is a practice of recent times.

Our first attempts (Saldanha, 1982) consisted of squeezing pure formalin into the holes of the animals, but the results obtained were very poor. Several other methods, using mainly chemicals, were also unsuccessful. Following a suggestion by Francis Zino, one of us (M.B.) started to use common salt (Cl Na) to collect the garden eels in the summer of 1985. This very simple method proved to be very satisfactory:

— A fair quantity of salt crystals (taken down in a plastic bag) is put into and over the hole.

— Over the hole a noose of nylon attached to the end of a stick and with its free end sliding through rings along the stick is laid.

— After some 5 to 15 minutes, when the animal will emerge from the hole a quick pull must be given to the free end of the nylon line to ensnare it by the head or trunk before it has time to escape back into the hole.

Several of the specimens collected in the waters of Madeira and represented among the material of the present paper were taken applying the above mentioned technique.

Material examined:

Abbreviations used: ANSP — Academy of Natural Sciences - Philadelphia
 BMNH — British Museum (Natural History)
 MB — Museu Bocage
 MMF — Museu Municipal do Funchal
 MNHN — Muséum National d'Histoire Naturelle - Paris
 SIO — Scripps Institution of Oceanography

a) previously identified as *Heteroconger longissimus*:

Holotype BMNH 1981.8.5:3 (Lanzarote, Canary Islands, 491mm Total Length [TL]).

Madeira — 38 specimens (340-525mm TL) collected in the region of Funchal by scuba diving, in depths between 16-18m; some specimens

from the stomach of other fishes and some swimming freely near the surface.

MB 2535, 518mm TL; MB 2536, 411mm TL ♀; MB 2537, 398mm TL. MMF 24058, 422mm TL; MMF 24059, 458mm TL; MMF 24060, 371mm TL; MMF 24061, 484mm TL; MMF 24017, 419mm TL ♀; MMF 24018, 428mm TL ♀; MMF 24019, 436mm TL ♀; MMF 24020, 370mm TL ♀; MMF 24062, 473mm TL ♀; MMF 24063, 464mm TL ♂; MMF 24064, 417mm TL; MMF 24065, 444mm TL; MMF 24066, 481mm TL; MMF 24067, 446mm TL ♀; MMF 23890, 507mm TL; MMF 23891 (4 specimens), 486, 426, 390, 395mm TL; MMF 2425, 411mm TL (collecting data unknown); MMF 2831, 340mm TL (collected at night at the surface, in the harbour of Funchal, on 24th Jan. 1943); MMF 7559, 462mm TL (from the stomach of *Pagellus erythrinus*, 1955); MMF 7598, 503mm TL (idem); MMF 8076, (very damaged, from the stomach of *Pagrus pagrus*, 1956); MMF 8492, 457mm TL (from the stomach of *Phycis phycis*?, 1956); MMF 9116, 525mm TL (Garajau, 1956); MMF 9119, 523mm TL (idem); MMF 9123, 464mm TL (idem); MMF 9125, 454mm TL (idem); MMF 9127, 459mm TL (idem).

Senegal — 2 specimens (243 and 345mm TL):

MNHN 1975-1171, 243mm TL (washed ashore on the beach of Gorée Island, 1950); MNHN 1975-1172, 345mm TL (from the stomach of *Epinephelus aeneus*, trawled at depths of 45-47m off the Saloum estuary, 1958).

b) previously identified as *Heteroconger halis* (= *Nystactichthys halis*):

Canary Islands — 5 specimens: 361, 400, 429, 439, 459mm TL (collected at Tenerife by scuba diving and sent to us by A. Brito Hernandez in 1982).

Western Atlantic — 29 specimens (105-338mm TL) distributed as follows:

British West Indies — ANSP 103295 (20 specimens), 248, 258 (2), 275, 279, 282, 283, 288, 296, 302, 303, 304 (2), 305, 307, 312, 315, 321, 323, 338mm TL (Anguilla Island, Dowlings shoal, off N end of Sand Island, 50-55 feet, 1965).

Panama, Atlantic — SIO 71-269.26, 305mm TL (San Blas archipelago, Holandes Cay, 60-70 feet deep, 1970); SIO 76-172 (2 specimens), 255-293mm TL (idem, 1975).

Florida — SIO 70-173 (6 specimens), 105 (formerly 107), 110, 111, 125, 150, 205 (formerly 210)mm TL (1972).

Vertebral counts:

Stained specimens from Madeira (MMF 9114, 9117, 9120, 9121, 9122) and from the western Atlantic (SIO 71-269) were used for vertebral counts, caudal skeleton examination and osteological characters in

general. Radiographs of 18 specimens were also used for vertebral counts.

Morphometry and meristic characters:

Measurements are those currently used in anguilliform taxonomy (cf. Merrett & Saldanha, 1985). Counts of lateral line pores were made on the left side of the animal. Cephalic lateral pores were counted on both sides of the head. In the global data matrix (cf. Table I) only those on the left side were included.

Principal component analysis:

To avoid possible subjective conclusions on the material here presented we used a principal component analysis as described by Gower (1966).

The specimens from all the geographic areas we obtained were treated individually, with the aim of establishing their group structure. Instead of considering groups of animals according to their geographical origin we preferred the individual treatment in order not to introduce *a priori* any geographical bias.

Each specimen (in a total number of 69) was described by a set of 22 values corresponding to the following list:

- 1 Total length
- 2 Head length
- 3 Preorbital length
- 4 Eye diameter
- 5 Interorbital width
- 6 Jaw length
- 7 Gill slit length
- 8 Pectoral fin length
- 9 Predorsal fin length
- 10 Preanal length
- 11 Preanal fin length
- 12 Body depth at gill slit (GS)
- 13 " " " anus (A)
- 14 " " " the beginning of caudal region (BCR)
- 15 " " " half caudal region (HCR)
- 16 Number of lateral line pores before gill slit
- 17 " " " " " " " anus
- 18 Number of cephalic pores: supraorbital canal
- 19 " " " " " " " infraorbital "
- 20 " " " " " " " preoperculomandibular canal
- 21 Ethmoid tooth (1/0)
- 22 Number of vertebrae

The principal component analysis was applied to a data matrix of dimension 69 x 22 (table I).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	491	22.0	4.0	3.0	2.0	4.0	2.0	1.0	30.0	188	*****	4.0	4.0	4.0	5.0	*****	*****	*****	2.0	*****	0	169
2	516	23.0	3.0	4.0	3.0	4.0	2.0	1.5	23.0	188	199.0	8.0	8.0	8.0	7.0	4.0	52.0	3.0	2.0	5.0	1	177
3	411	21.0	2.5	4.0	2.0	4.0	1.5	1.5	24.0	133	139.0	7.0	5.0	6.0	6.0	3.0	50.0	3.0	2.0	5.0	1	166
4	398	21.0	3.0	3.5	3.0	4.0	2.0	1.0	22.0	127	133.0	7.0	6.0	6.0	7.0	4.0	50.0	3.0	2.0	5.0	1	***
5	422	21.0	3.0	4.0	3.0	3.0	2.0	1.5	26.0	140	146.0	6.0	6.0	6.0	7.0	3.0	50.0	3.0	2.0	5.0	1	***
6	498	24.0	4.0	4.0	3.0	4.0	2.0	2.0	28.0	143	147.0	7.0	7.0	7.0	7.0	2.0	45.0	3.0	2.0	5.0	1	***
7	371	20.0	3.0	4.0	3.0	3.0	1.5	1.5	23.0	117	155.0	6.0	6.0	6.0	6.0	3.0	40.0	3.0	2.0	5.0	1	***
8	484	23.0	4.0	4.0	3.0	4.0	2.0	1.5	23.0	152	157.0	7.0	7.0	7.0	7.0	3.0	46.0	3.0	2.0	5.0	1	***
9	419	20.0	3.0	4.0	3.0	4.0	2.0	1.5	26.0	132	142.0	7.0	7.0	6.0	7.0	3.0	52.0	3.0	2.0	5.0	1	***
10	429	20.0	3.0	4.0	4.0	3.5	2.5	2.0	22.0	136	142.0	7.0	7.0	6.0	6.0	2.0	48.0	3.0	2.0	5.0	1	***
11	436	22.0	3.5	4.0	4.0	3.5	2.0	2.0	28.0	146	153.0	7.0	6.5	7.0	6.5	2.0	52.0	3.0	2.0	5.0	1	***
12	370	18.0	3.0	4.0	3.0	4.0	2.0	1.0	21.5	120	124.0	6.0	6.0	5.5	5.5	2.0	32.0	3.0	2.0	5.0	0	***
13	473	22.0	2.0	3.5	3.0	4.0	2.0	1.0	27.0	153	157.0	7.0	6.0	6.0	6.0	3.0	51.0	3.0	2.0	5.0	0	***
14	464	22.0	3.0	3.0	2.0	3.0	2.0	2.0	30.0	158	162.0	8.0	6.0	6.0	6.0	2.0	46.0	3.0	2.0	5.0	0	***
15	417	19.0	3.0	3.0	2.0	3.0	3.0	1.5	25.0	140	144.0	6.0	6.0	6.0	6.0	2.0	54.0	3.0	2.0	5.0	1	***
16	444	21.0	3.0	3.5	2.0	3.0	2.0	2.0	26.0	139	142.0	7.0	7.0	6.0	6.0	2.0	49.0	3.0	2.0	5.0	1	***
17	481	22.0	4.0	3.0	2.0	3.0	2.0	2.0	28.0	149	153.0	7.0	7.0	7.0	7.0	2.0	50.0	2.0	2.0	5.0	1	***
18	446	20.0	2.0	3.0	2.0	4.0	3.0	2.0	30.0	138	142.0	6.0	6.0	6.0	6.0	2.0	49.0	3.0	2.0	5.0	1	***
19	507	24.0	3.0	2.0	3.0	2.0	3.0	2.0	26.0	150	157.0	7.0	7.0	6.0	6.0	4.0	50.0	3.0	2.0	5.0	0	***
20	426	22.0	3.0	3.0	3.0	3.0	3.0	2.0	22.0	131	134.0	6.0	6.0	6.0	6.0	3.0	50.0	3.0	2.0	5.0	0	***
21	426	21.0	3.0	4.0	3.0	3.0	2.0	1.0	22.0	126	131.0	6.0	6.0	6.0	6.0	3.0	50.0	3.0	2.0	5.0	1	***
22	390	20.0	3.0	2.5	2.0	3.0	2.0	1.0	24.0	126	131.0	6.0	6.0	6.0	6.0	4.0	53.0	3.0	2.0	5.0	1	***
23	395	21.0	3.0	3.0	4.0	3.0	2.0	1.5	23.0	129	133.0	7.0	7.0	6.0	7.0	2.0	50.0	3.0	2.0	5.0	1	***
24	411	21.0	3.0	3.5	3.0	4.0	2.0	1.0	23.0	131	136.0	7.0	7.0	6.0	7.0	4.0	50.0	3.0	2.0	5.0	1	171
25	340	19.0	3.0	4.0	3.0	3.0	2.0	1.0	22.0	110	115.0	6.0	6.0	5.0	5.0	3.0	32.0	3.0	2.0	5.0	1	***
26	462	21.0	3.0	4.0	3.0	4.0	2.0	1.0	24.0	131	*****	7.0	6.0	*****	6.5	*****	*****	*****	*****	*****	0	***
27	503	21.0	3.0	4.0	3.0	4.0	2.0	1.0	25.0	154	159.0	7.0	7.0	6.0	7.0	*****	*****	*****	*****	*****	0	172
28	457	21.0	3.0	4.0	3.0	4.5	2.0	1.0	26.0	150	156.0	7.0	7.0	6.0	7.0	*****	*****	*****	*****	*****	0	***
29	525	27.0	4.0	4.0	3.0	4.0	3.0	2.0	30.0	175	179.0	8.0	8.0	7.0	8.0	4.0	50.0	3.0	2.0	5.0	1	171
30	523	23.0	4.0	4.0	3.0	4.0	3.0	1.5	26.0	167	173.0	7.0	7.0	6.0	7.0	3.0	47.0	3.0	2.0	5.0	1	171
31	464	21.0	3.0	4.0	3.0	3.0	2.0	1.0	26.0	152	156.0	7.0	7.0	6.0	7.0	4.0	53.0	3.0	2.0	5.0	1	169
32	454	21.5	3.0	4.0	3.0	3.0	2.0	1.0	30.0	146	149.0	7.0	6.5	6.0	6.5	3.0	50.0	3.0	2.0	5.0	1	169
33	499	22.5	3.0	4.0	3.0	3.5	3.0	1.0	27.0	150	155.0	7.0	7.0	7.0	7.0	3.0	50.0	3.0	2.0	5.0	1	176
34	243	16.0	2.0	3.0	2.0	3.5	2.0	1.0	24.0	83	86.0	6.0	6.0	5.0	5.0	4.0	*****	3.0	4.0	7.0	1	164
35	365	20.0	3.0	4.0	2.0	4.0	2.0	1.0	25.0	116	120.0	6.0	5.0	5.0	5.0	3.0	50.0	3.0	2.0	5.0	0	165
36	459	20.0	3.0	4.0	2.5	3.0	2.0	1.5	23.0	142	149.0	7.0	6.0	6.0	6.0	4.0	52.0	3.0	2.0	5.0	0	171
37	429	20.0	3.0	4.0	3.0	3.0	2.0	2.0	23.0	129	134.0	6.0	6.0	6.0	6.0	2.0	50.0	3.0	2.0	5.0	0	165
38	439	21.0	3.0	4.0	3.0	3.0	2.0	1.0	25.0	129	133.0	6.0	6.0	6.0	6.0	2.0	46.0	3.0	2.0	5.0	0	170
39	361	18.5	3.0	4.0	2.0	2.0	2.0	1.0	22.0	121	126.0	6.0	5.0	5.0	5.0	4.0	55.0	3.0	2.0	5.0	1	171
40	400	20.0	3.0	4.0	3.0	3.0	2.0	1.0	26.0	120	124.0	6.0	5.0	6.0	5.0	4.0	53.0	3.0	2.0	5.0	0	167
41	304	17.0	3.0	4.0	3.0	3.0	2.0	1.0	21.0	97	101.0	6.0	5.0	5.0	5.0	3.0	47.0	3.0	2.0	5.0	0	162
42	305	17.0	3.0	3.5	2.0	2.0	2.0	1.5	21.0	100	104.0	6.0	5.0	5.0	5.0	3.0	51.0	3.0	2.0	5.0	1	169
43	307	17.0	3.0	3.0	2.0	2.0	2.0	1.0	20.0	106	110.0	6.0	5.0	5.0	5.0	3.0	50.0	3.0	2.0	5.0	0	***
44	252	17.0	3.5	2.0	3.0	2.0	2.0	1.0	18.0	96	99.0	4.0	5.0	5.0	5.0	3.0	47.0	3.0	2.0	5.0	1	162
45	121	17.0	2.0	3.0	3.0	2.0	2.0	1.0	20.0	98	103.0	4.0	5.0	4.0	5.0	1.0	47.0	3.0	2.0	5.0	1	166
46	364	16.0	3.0	3.0	2.0	3.0	3.0	1.0	20.0	95	98.0	4.0	5.0	5.0	5.0	3.0	47.0	3.0	2.0	5.0	1	161
47	279	16.0	3.0	3.0	3.0	3.0	1.5	1.0	19.0	92	97.0	6.0	4.0	5.0	5.0	3.0	50.0	3.0	2.0	5.0	1	164
48	258	15.0	3.0	3.0	2.5	1.5	1.0	19.0	84	87.0	6.0	4.0	5.0	5.0	4.0	2.0	48.0	3.0	2.0	5.0	1	168
49	250	16.0	2.0	3.0	2.0	2.0	2.0	1.0	18.0	86	89.0	6.0	5.0	5.0	5.0	3.0	50.0	3.0	2.0	5.0	1	159
50	303	17.0	2.5	4.0	3.0	3.0	2.0	1.0	21.0	102	107.0	6.0	5.0	5.0	5.0	2.0	49.0	4.0	2.0	5.0	1	174
51	248	14.0	2.0	3.0	2.0	2.0	2.0	1.5	17.0	84	87.0	5.0	4.0	4.0	4.0	3.0	52.0	3.0	2.0	5.0	1	***
52	328	18.0	2.5	3.5	2.0	2.0	2.0	2.0	22.0	118	123.0	6.0	5.0	6.0	5.0	2.0	52.0	3.0	2.0	5.0	1	***
53	283	16.0	2.5	3.0	2.5	2.0	1.5	1.5	19.0	92	97.0	6.0	5.0	6.0	5.0	3.0	49.0	3.0	2.0	5.0	1	***
54	315	17.0	3.0	3.0	2.5	2.0	2.0	1.5	20.0	98	102.0	6.0	5.0	6.0	5.0	3.0	48.0	3.0	2.0	5.0	1	***
55	312	17.0	3.0	3.0	2.0	2.0	2.0	1.5	20.0	98	102.0	6.0	5.0	5.0	5.0	3.0	40.0	3.0	2.0	5.0	0	***
56	302	16.0	3.0	4.0	2.0	2.0	1.5	2.0	19.0	102	107.0	6.0	5.0	5.0	5.0	3.0	52.0	3.0	2.0	5.0	1	***
57	323	18.0	3.0	4.0	3.0	3.0	2.0	1.0	20.0	103	106.0	6.0	5.0	5.0	5.0	3.0	50.0	3.0	2.0	5.0	1	***
58	296	16.0	3.0	3.0	2.5	3.0	1.5	1.5	19.0	102	106.0	6.0	5.0	5.0	5.0	2.0	51.0	3.0	2.0	4.0	1	***
59	288	16.0	3.0	3.0	2.5	2.5	2.0	1.5	19.0	98	101.0	6.0	5.0	5.0	5.0	2.0	51.0	3.0	2.0	4.0	1	***
60	275	15.0	3.0	3.5	2.0	2.0	2.0	1.5	18.0	93	97.0	6.0	5.0	5.0	5.0	2.0	51.0	3.0	2.0	4.0	1	***
61	305	15.0	1.6	3.0	2.0	2.0	2.0	1.0	18.0	130	131.0	5.0	4.0	5.0	5.0	2.0	50.0	3.0	2.0	4.0	1	***
62	205	11.0	1.4	0.0	*****	2.4	*****	0.8	18.0	103	*****	4.0	4.0	4.0	4.0	2.0	45.0	3.0	2.0	3.0	1	***
63	150	10.0	1.0	1.7	*****	1.4	*****	0.3	13.0	55	*****	3.0	3.0	2.5	3.0	4.0	47.0	3.0	2.0	5.0	1	***
64	125	9.0	1.0	1.8	*****	1.4	*****	0.3	11.0	47	*****	3.5	3.0	3.0	3.0	4.0	46.0	3.0	2.0	5.0	1	***
65	111	8.0	0.8	1.3	*****	1.4	*****	0.3	11.0	42	*****	3.0	2.5	2.0	2.5	5.0	46.0</					

Some of the morphological characters deserve close examination:

Pectoral fin — This fin is generally minute, with its free edge rounded or more pointed. In some dead specimens this fin was directed forward covering the branchial aperture. This position corresponds perhaps to what may happen when the animal goes backwards into its hole. The inverted pectoral fin could then protect the branchial aperture.

Counting the rays is sometimes difficult even in stained specimens. In those from Madeira we counted 9, 11 and 12 rays (doubtful counts such as 7(?), 8(?) or 11(?)) were excluded as well as 9(?) in the holotype. For the specimens from Senegal Kanazawa (1961) recorded 14 rays and Blache & Bauchot (1976) some 14 or 15 rays. Blache (1977) gives 12-14 for larvae collected in the Gulf of Guinea. Böhlke (1957) mentions 11-12 tiny rays for the western Atlantic specimens. Assuming that specimens from both sides of the Atlantic belong to the same species (cf. below) a range of 9 to 14 or 15 can be established.

Caudal fin — In all the specimens (from all the geographical origins) the tail tip, typical of a tail-burrowing eel, is hard and fleshy with fin rays not evident externally and vertical fins terminating externally before the end of the tail (as recorded by Böhlke & Randall, 1981). Allowing for a certain amount of individual structural variation in the composition of the osseous components of the caudal skeleton (see figs. 1-4) the specimens from both sides of the Atlantic here examined, including the drawing by Böhlke (1957, fig. 6D, p. 77) proved to be identical.

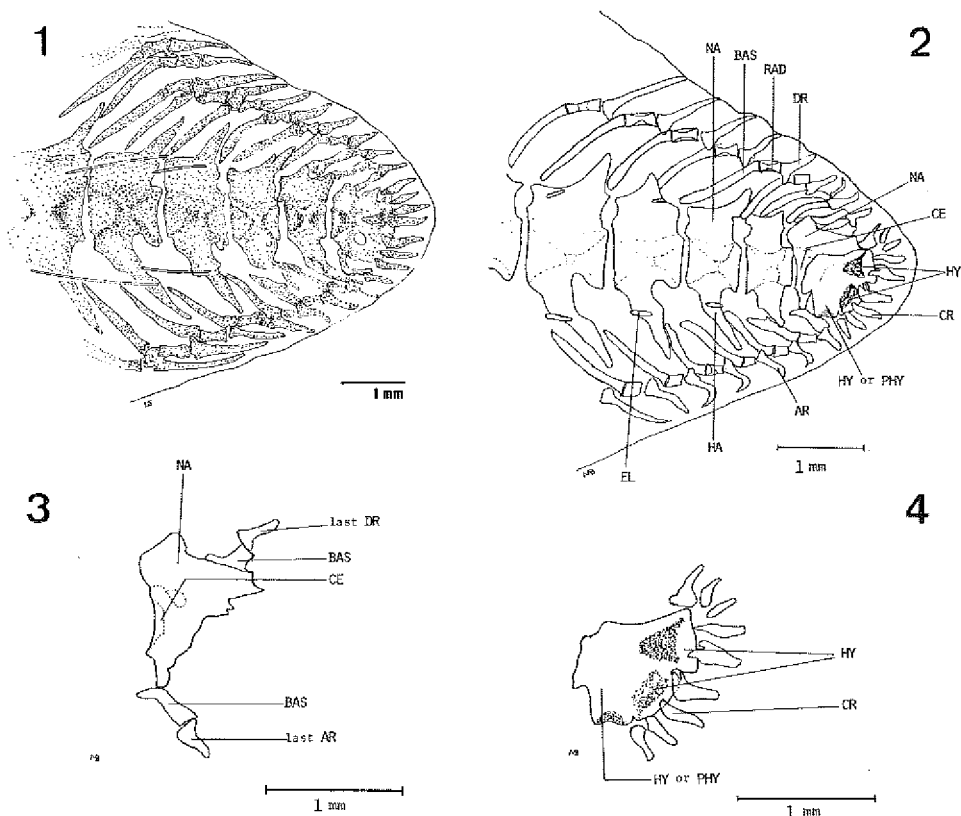
In specimens from Madeira the hypurals bear 4+3 or 4+4 caudal rays. Blache (1977) gives 4-5+3-5 for larvae from the Gulf of Guinea. In a stained specimen from the western Atlantic (Panama) we observed 4+4 rays. Böhlke (1957) mentions 4+3 for western Atlantic specimens. There is, therefore, agreement among all these figures.

However the details shown in figs. 3 and 4 show an appreciable variation between the animals.

Fig. 1 of specimen MMF 9121 does not show up the two hypurals very clearly. Apart from this fig. 4 of specimen MMF 9114 suggests the presence of more than two fused hypurals, or one parhypural and two hypurals. Rosenblatt (1967) mentions for *Gorgasia punctata* Meek & Hildebrand, 1923 a large hypural plate consisting of several fused hypurals.

A further difference between specimen MMF 9114 and all the others examined by us, including the specimen from Panama is in the absence of a foramen in the ventral part of the hypural plate. The by us so-called parhypural or hypural is not so evident in the other 3 animals examined.

A curious feature observed in all 4 stained specimens from Madeira is the fact that the last two pterygiophores support together one single ray, both dorsally and anally. Böhlke (1957) already showed this feature in fig. 6D but did not expound on it. According to Rosenblatt's fig. 4 (1967)



Figs. 1-4. — Skeletal details of the caudal complex of *H. longissimus*. 1: caudal complex of specimen MMF 9121. 2: last five vertebrae of specimen MMF 9114, lateral view. 3: Last vertebra of specimen MMF 9114. 4: Hypural plate with caudal rays of specimen MMF 9114.

AR, anal ray; BAS, basal element of pterygiophore; CE, centrum; CR, caudal ray; DR, dorsal ray; EL, epipleural; HA, haemal arch; HY, hypural; NA, neural arch; PHY, parhypural; RAD, radial element of pterygiophore.

this does not seem to be the case in *G. punctata*. Regarding all other species of the Heterocongrinae we can say nothing about this feature.

As is well known the morphology of the caudal skeleton is a useful character, at least at the generic level (observed by us, for example, in synphobranchids) but probably also at the specific level (Böhlke & Randall, 1981).

Lateralis system — The lateral line in all the specimens runs along the whole body coming to an end near the tip of the tail. The number of

pores (before the gill slit and before the anus) is nearly the same in all the material examined and recorded in the literature:

— Before the gill slits (in brackets the number of observations):

Holotype — ?

Madeira — 2(8), 3(12), 4(9)

Canary Is. — 2(2), 4(3)

Senegal — 4(1), 5(1)

Western Atlantic — 1(1), 2(10), 3(12), 4(4), 5(2)

Böhlke (1957) recorded 2 to 4 pores before the anterior end of the pectoral fin.

— Before the level of the anus:

Holotype — ?

Madeira — 47(1), 48(3), 49(3), 50(11), 51(1), 52(6), 53(2), 54(2)

Canary Is. — 46(1), 50(1), 52(1), 53(1), 55(1)

Senegal — ?

Western Atlantic — 45(1), 46(2), 47(4), 48(3), 49(3), 50(6), 51(5), 52(3)

The total number of pores in the lateral line given by Böhlke (1957) is 132 to 139. In eleven specimens from Madeira we observed 131 to 154 pores (131, 134, 139, 142, 143, 144(2), 145, 149(2), 154) and 133, 134 and 145 pores in the specimens from the Anguilla Is. (British West Indies).

In this material the range from the western Atlantic is included in that of the eastern Atlantic.

In the cephalic lateralis system the number of pores and its distribution pattern (cf. Saldanha, 1982) is similar in all specimens with few exceptions, due in most cases to individual variability.

As a rule there are three pores in the supraorbital canal, two in the infraorbital and five in the preoperculomandibular one. The two specimens from Senegal deserve special mention (see below), as they present more pores in the infraorbital and preoperculomandibular canal.

In the supraorbital canal the first pore is placed near the middle of the upper jaw, on the lip and between the two anterior nostrils, the second in the snout near the lip and the third near the anterior margin of the eye and the posterior nostrils.

In a specimen from Madeira and another from the western Atlantic there were only two supraorbital pores, the pores on the lip lacking. In a specimen from the western Atlantic there were four supraorbital pores on the left side of the head (an extra pore between the posterior two). The two specimens from Senegal present the usual three pores (at least in one specimen, while in the other one the tip of snout is damaged) but the posterior pore is placed slightly in a more forward position than usual. Blache & Bauchot (1976) found three pores in this canal.

The first pore of the infraorbital canal is placed at the side of the snout tip near the second pore of the supraorbital canal and another pore

is placed above the angle of the mouth. In only one specimen from the western Atlantic, of all specimens examined, the first pore is lacking on the left side of the head.

Also the two specimens from Senegal present the two infraorbital pores but this canal has a postorbital ascending branch. In one of the specimens it presents three pores on the right side and two pores on the left side. On both sides the superior pore is placed near the upper part of the posterior margin of the eye. In the other specimen we observed also three pores on the left side and two on the right side. The two superior pores on each side are very conspicuous. The bad preservation of this specimen prevented careful observation of the pores in general.

The preoperculomandibular canal presents four pores along the lower jaw and one pore placed in a preopercular position. In the material from Madeira we observed two specimens with only three pores on the right side of the jaw and in another specimen the preopercular pore is lacking on the left side.

Regarding the material from the Canary Is. one specimen presents the four mandibular pores not so regularly spaced (on the right side) as they usually are in other specimens.

One specimen from the western Atlantic presents five pores both on the right and left mandible and another one three pores on the left mandible and four on the right one. In two specimens the preopercular pore is lacking on one of the sides.

In the two specimens from Senegal there are 4 mandibular pores (covered by the lip) and two preopercular pores (three on the left side of one specimen).

Due to the bad state of preservation of the holotype only two pores could be observed on the supraorbital canal, the skin of the lips being badly damaged as well as the lower jaw where only two pores could be observed. The preopercular pore is present. The two infraorbital pores could also be observed.

In general terms from the 69 specimens examined there are only 9 (from different geographic origins) that present slight differences in the number of cephalic pores. In these 9 specimens the two from Senegal are included, the most widely differing ones among the material examined. This general scheme agrees with that reported by Böhlke (1957) for *H. halis*. Based on the arrangement and number of the lateral pores both of the head and the lateral line we see no reason to consider the taxa under consideration two separate species.

Dentition: The dentition of several specimens observed from all the localities represented in the studied material, including the holotype, proved to be very similar to the general scheme described by Böhlke (1957) for *H. halis* and by Blache & Bauchot (1976) for *H. longissimus*. The variability observed was equivalent for each geographic locality and we were unable to distinguish a peculiar pattern for any.

We recorded in the anterior part of the maxillary 3-4 rows of cardi-form teeth followed posteriorly by a uniserial row of 7-8 large teeth (sometimes 6). The premaxillary-vomerine patch presents anteriorly some 5-8 rows of teeth sometimes densely placed followed posteriorly by two groups of teeth, the first being irregularly triserial or biserial and the second generally uniserial, comprising a total of 6-18 rows of teeth. The mandible presents 2-4 serial rows of teeth anteriorly and one posteriorly.

The existence of an ethmoid tooth in *H. halis* (cf. Böhlke, 1957) was one of the reasons for Böhlke (pers. comm.) to insist on distinguishing this species from *H. longissimus* (see also Böhlke & Randall, 1981). In the material here presented the ethmoid tooth is generally conspicuous in the specimens from the western Atlantic but may sometimes lack as observed in two specimens from the Anguilla Is. In the specimens from the eastern Atlantic the tooth may be present or absent. It is absent in thirteen specimens from Madeira, one from Senegal and four from the Canary Is. (considered by Brito and Cruz [pers. com.] *H. halis*). In the holotype the tooth is absent. In many specimens from the eastern Atlantic this tooth is sometimes difficult to observe and its presence is to be searched within the tissues with the help of thin needles. Its absence may sometimes be due to rough manipulation of the specimens and thus breaking the tooth, as we have observed in several cases. This tooth may also sometimes be conspicuous in specimens from the eastern Atlantic where one of the specimens from Madeira presented two teeth.

Based on the observation above it is our opinion that the presence or absence of the ethmoid tooth is not a valid character to divide the studied specimens into two different species.

Vertebrae — The range of vertebral counts (excluding the hypural plate) made on Madeiran specimens is comprised between 162 and 177 (162, 165 (2), 166, 167, 168, 169 (2), 171 (2), 172, 173, 176, 177) and those made on Canary Islands material between 167 and 175 (167, 168, 171 (2), 175). The two specimens from Senegal present 164 and 165 vertebrae. The holotype of *H. longissimus* from the Canary Islands presents 169. Böhlke (1957) gives 165 for *H. halis* and our counts for the specimens from the western Atlantic gave a range of 158 to 166 (158, 159, 160, 161, 162 (2), 164 (2), 166). Blache (1963, 1977) gave a range of 166-167 for the adult and 162-175 myomeres for the larvae. E. Böhlke (pers. com.) gave a range of 157-169 for *H. halis* and 166-173 for *H. longissimus* (from Madeira and the Canaries).

The range from the western Atlantic is smaller than that of the eastern Atlantic, but there is some overlapping between the two. Consequently there is no reason to consider the existence of two different species on the basis of counts of vertebrae. A total range of 157-177 is perfectly admissible as a variation as large as 19 vertebrae has already been observed in other anguilliform fishes.

Coloration — Data on coloration were obtained observing fresh material from Madeira which correspond to those observed by Böhlke (1957) for *H. halli*.

The anterior two thirds of the body are brown and the posterior third lighter and similar to the anterior portion of the belly. This first area corresponds to the portion of the animal outside the hole when in its characteristic position during the day sticking out from the bottom in a slightly bent position.

The ventral part of the branchial region is white (with small dark spots) and there are small yellow spots sprinkled all over the body. Sometimes the pores on the lateral line are whitish.

Principal component analysis — Morphological similarity among all the specimens examined was established using the principal component analysis.

	1	2
1	11.0603	50.2743
2	2.0124	9.1471
3	1.5601	7.0913
4	1.2890	5.8589
5	1.2212	5.5511
6	1.0619	4.8266
7	0.9660	4.3909
8	0.6598	2.9990
9	0.5292	2.4056
10	0.4248	1.9308
11	0.3893	1.7698
12	0.3393	1.5421
13	0.2786	1.2645
14	0.2626	1.1937
15	0.2470	1.1229
16	0.1418	0.6444
17	0.1387	0.6305
18	0.0716	0.3256
19	0.0612	0.2780
20	0.0475	0.2161
21	0.0320	0.1435
22	0.0144	0.0653

Tab. II. — Eigenvalues (1) and variability percent (2) on the 22 principal axes extracted.

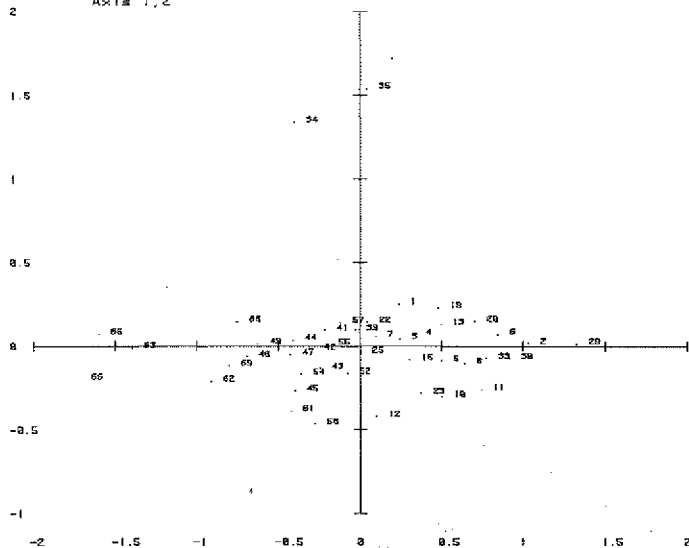
Examining the eigenvalue list (table II) it may be seen that 50.3% of the total variability is concentrated on principal axis 1, with 9.1% on axis 2 and 7.1% on axis 3. Accordingly the grouping of individuals (fig. 5) is mainly produced by the characters with major contributions along axis 1 (fig. 6).

The characters in question are as follows:

Total length (1), superimposed with preanal length (10) and body depth A(13), BCR(14) and HCR(15).

Heterocenger - P.C.A. - Individuals

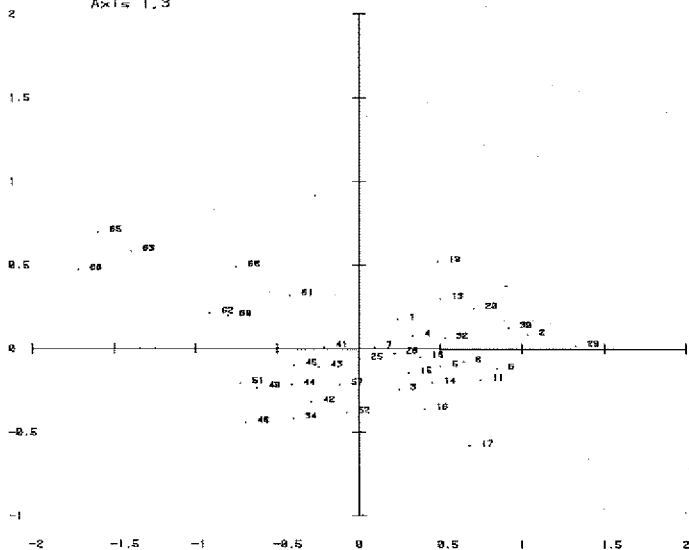
Axis 1,2



SUPERIMPOSED POINTS: 9,8; 14,5; 16,19; 17,8; 18,4; 21,3; 24,4; 25,3; 27,20; 28,20; 31,27; 32,5; 36,13;
37,5; 38,15; 40,1; 46,42; 50,63; 51,68; 53,47; 56,42; 59,43; 60,53; 64,63; 67,66.

Heterocenger - P.C.A. - Individuals

Axis 1,3

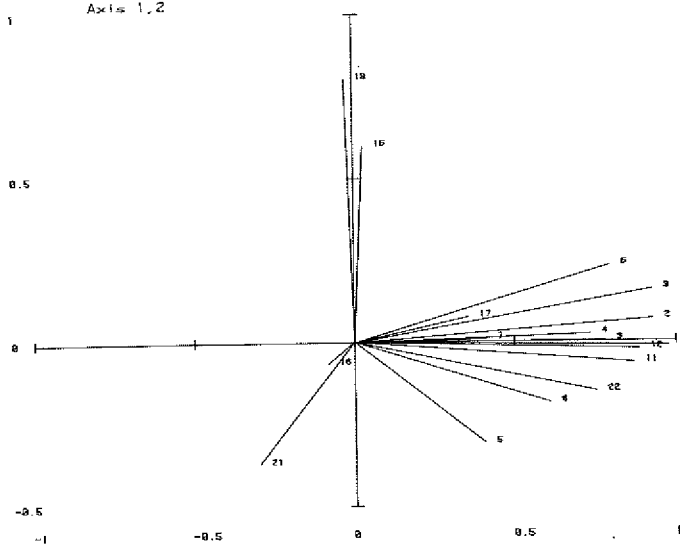


SUPERIMPOSED POINTS: 9,8; 10,5; 12,7; 21,1; 22,7; 23,18; 24,4; 27,20; 28,20; 31,20; 33,20; 35,25; 36,32;
37,5; 38,1; 39,25; 40,1; 46,45; 47,44; 50,61; 53,44; 56,44; 55,43; 56,42; 58,42; 59,42; 60,34; 64,63; 67,66.

Fig. 5.— Distribution of individuals along principal axis.

Heteroconger - P.C.A. - Characters

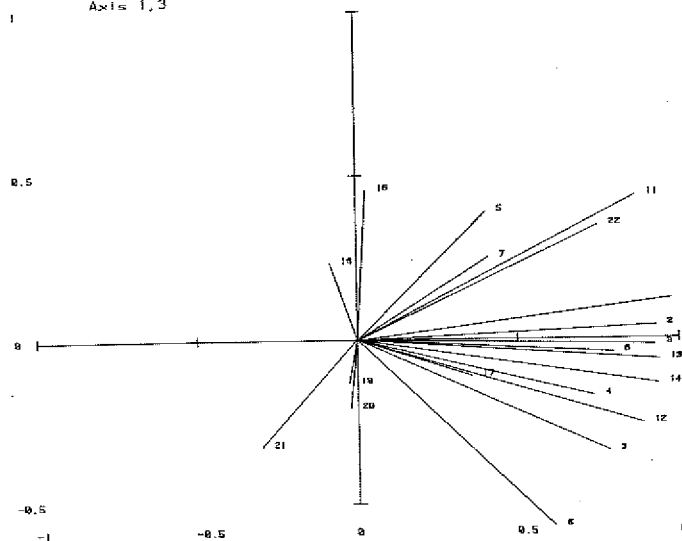
Axis 1,2



SUPERIMPOSED POINTS: 10,1; 13,10; 14,10; 15,1; 20,19.

Heteroconger - P.C.A. - Characters

Axis 1,3



SUPERIMPOSED POINTS: 10,1; 15,9.

Fig. 6.—Distribution of characters along principal axis.

head length (2)
 predorsal fin length (9)
 preanal fin length (11)
 body depth GS(12)

This kind of distribution accounts for the presence of a size gradient (specimens 66 and 67 — 110, 105mm TL from Florida; specimen 29 — 525mm TL from Madeira) within the whole sample studied (69 individuals).

The distribution of individuals along the principal axis 2 and '3 (fig. 5) presenting a much smaller variability (16.1%), is due to the structure of the cephalic lateralis system, corresponding to the number of pores in the lateral line before gill slit (16), infraorbital canal (19), preoperculo-mandibular canal (20) and the presence of the ethmoid tooth (21) as represented in fig. 6. In this respect we can individualize specimens 34 and 35 which present the highest number of pores in the infraorbital and preoperculo-mandibular canals.

As the number of specimens in which we could count the vertebrae is small (25 specimens in 69) it is not possible to include this character in the final interpretation. At any rate it can be seen (fig. 6) that this character (22) is strongly correlated with the dimensional characters we considered for the interpretation of axis 1 (1, 10, 13, 14, 15, 2, 9, 11, 12).

4. CONCLUSIONS

The morphological similarity observed for all the specimens examined from both sides of the Atlantic was objectively demonstrated by the principal component analysis.

Since the whole range of variability can be found between individual 29 (the largest in size) and individuals 63, 64, 65, 66 and 67 (the smallest of all the 69 sampled) we shall consider the whole sample belonging to the same species.

We shall therefore consider *Heteroconger halis* (Böhike, 1957) a junior synonym of *Heteroconger longissimus* Günther, 1870. Its known geographical distribution covers therefore Madeira, the Canary Islands and Senegal in the eastern Atlantic and several areas in the western Atlantic such as Florida, Bahamas, Puerto Rico, Panama, Colombia and the Antilles.

Senegal is for the moment the southernmost limit of distribution of adults in the eastern Atlantic. The two specimens here presented are the only ones known from this region. We were not successful in obtaining positive answers from scientists and divers from Dakar to enquiries on the presence of the species in Senegambian waters. Further research is needed in this field since larvae were collected in the Gulf of Guinea (Blache, 1977) the larvae being more frequent in the area comprised between Ano Bom, Libreville and Pointe Noire becoming very rare south of the Congo estuary.

As was pointed out by Klauswitz (1971) larvae may be carried by currents between both sides of the Atlantic assuring a gene flow between

these populations. As is well known this possibility was observed not only in fishes but also in invertebrates and algae. Consequently there will be no geographical barriers between the populations of *H. longissimus*.

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BOCAGIANA

Museu Municipal do Funchal

Madeira

22.II. 1963

No. 9

NOTES ON TWO MADEIRA PLANTS

By N. C. H. KRAUSS ¹

The composite plant «Abundância» (*Eupatorium adenophorum* Spreng.) has been known in Madeira for many years. On July 24, 1962 I collected a second species of *Eupatorium*, *E. riparium* Schultz-Bip., confirmed by the Royal Botanic Garden, Kew, England. This was growing in association with *E. adenophorum* in a damp area along a path near Monte. Both these species of *Eupatorium* are native to Mexico. I have seen *E. riparium* growing along a small stream in a ravine at the Desierto de los Leones, Distrito Federal, in the hills above Mexico City. Both species are pests in grazing land in Hawaii.

On November 7, 1960 I collected specimens of *Ulex minor* Roth (determined by Royal Botanic Garden, Kew) in the grassy hills above Ribeiro Frio. Since then I have seen it also at Encumeada and Santo da Serra. *Ulex europaeus* L. has been known in Madeira for a long time, but I have not seen any records of *U. minor*.

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